Developing Shared Understanding through Knowledge Management:
Collaboration and Meaning Analysis Process (C-MAP)

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Report Documentation Page		*Form Approved* *OMB No. 0704-0188*

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1. REPORT DATE **JAN 2006**	2. REPORT TYPE	3. DATES COVERED **00-00-2006 to 00-00-2006**
4. TITLE AND SUBTITLE **Developing Shared Understanding through Knowledge Management: Collaboration and Meaning Analysis Process(C-MAP)**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Tennessee,Organizational Research Laboratory,Knoxville,TN,37996**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES **Collaboration and Knowledge Management (CKM) Workshop, 24-26 Jan 2006, Cambridge, MA. U.S. Government or Federal Rights License**		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT **Same as Report (SAR)**	18. NUMBER OF PAGES **49**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Research Team

Lisa Delise
Lab Manager

TBA: Technical Guru, Graduate Research Assistant

Long Term Goals/Project Objectives

Investigate propositions of the Structural Model of Team Collaboration including the macro-cognitive processes

Examine processes related to knowledge building, knowledge interoperability, and shared understanding

Long Term Goals/Project Objectives

Develop and investigate the Collaborative and Meaning Analysis Process (C-MAP) based on a foundation of team cognition research

Develop process measures of team cognition and collaboration

Develop a scientific basis for building supporting technologies for collaboration and knowledge building

Project Objectives
Initial Experiment

Obtain and establish a laboratory task
   Noncombatant Evacuation Operation

   (time pressure, cognitive overload, unique roles, heterogeneous knowledge)

Develop the Collaboration & Meaning Analysis Process
   (C-MAP)

Develop measures of cognition and meaning sharing
   (e.g., knowledge interoperability, shared understanding)

Conduct study

Research Questions: Background

STRUCTURAL MODEL OF TEAM COLLABORATION

Problem Area Characteristics

Collaborative Situation Parameters:

- time pressure
- information/knowledge uncertainty
- dynamic information
- large amount of knowledge (cognitive overload)
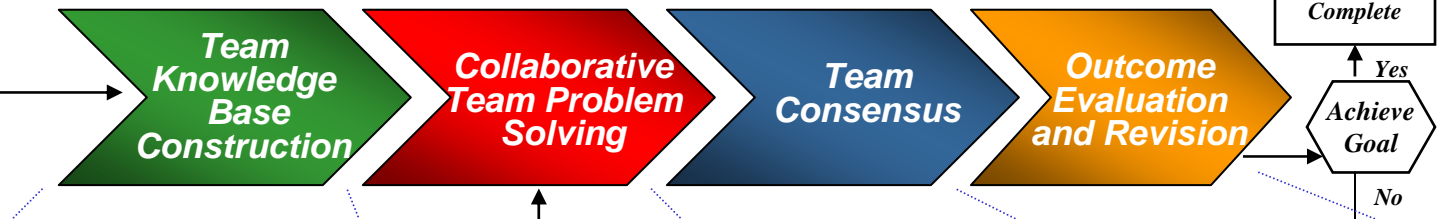- human-agent interface complexity

Team Types

- asynchronous
- distributed
- culturally diverse
- heterogeneous knowledge
- unique roles
- command structure (hierarchical vs. flat)
- rotating team members

Operational Tasks

- team decision making, COA selection
- develop shared understanding
- intelligence analysis (team data processing)

Collaboration Stages

| Team Knowledge Base Construction | Collaborative Team Problem Solving | Team Consensus | Outcome Evaluation and Revision |

Achieve Goal — Yes → Collaboration Complete / No

Meta-Cognitive:

- individual understanding of problem conditions
- individual mental model development of situational significance

- goal development
- team mental model of problem
- team plan to solve problem

- track team's mental model changes
- understanding remaining items to resolve

- compare problem solution against goals

Information Processing:

- problem identification
- understanding problem task
- establish team communication and trust
- establish data filtering methods
- establish meaning transfer conventions

- goal definition
- iterative information collection & analysis
- develop, rationalize, & visualize solution alternatives

- team negotiation of solution alternatives

- analyze, revise output

Knowledge Building:

- problem definition
- individual task knowledge
- individual team knowledge

- team mental model of team
- team task knowledge
- domain expertise
- shared understanding
- collaborative knowledge

- collaborative knowledge
- shared understanding

- goal requirements
- exit criteria

Communication Mechanism for Information Processing and Knowledge Building (applies to all stages):

- presenting individual information
- disagreement
- questioning

- discussing individual information
- negotiating perspectives
- discussion of possible solutions

- discussing team generated information
- providing rationale for individual solutions
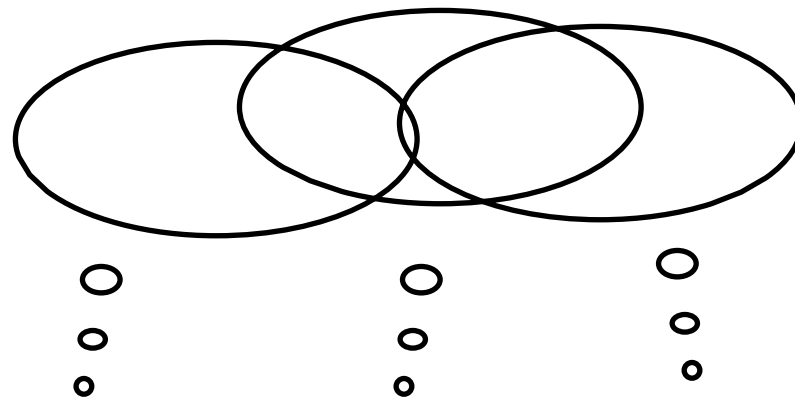- agreement

Team Member Schema Similarity (TMSS)

Team-Related Knowledge

NOT THIS

Research Questions: Background

Team Member Schema Similarity (TMSS)

THIS

Research Questions: Background

Team Member Schema Congruence

Donna's schema

Professionalism
Task-oriented

**Trust
Supporting others**

Speaking one's mind
Integrating ideas

Mitch's schema
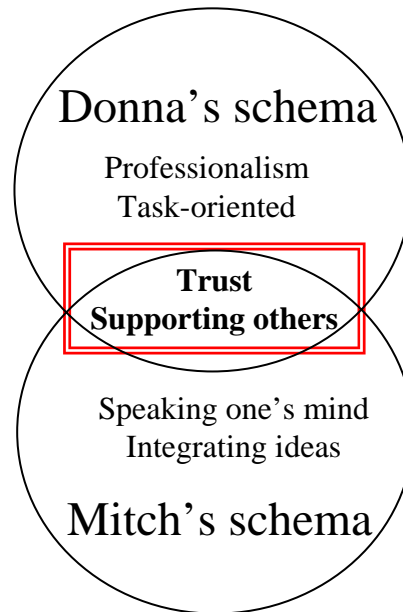
Congruence = A *match* between team members' schemas in content and/or structure

Team Member Schema Similarity Model

High Quality Information

Membership Influences

Schema Communications

Team Schema Congruence

Functional Knowledge

Enhanced Taskwork

Enhanced Teamwork

Team Effectiveness

Rentsch & Hall (1994)

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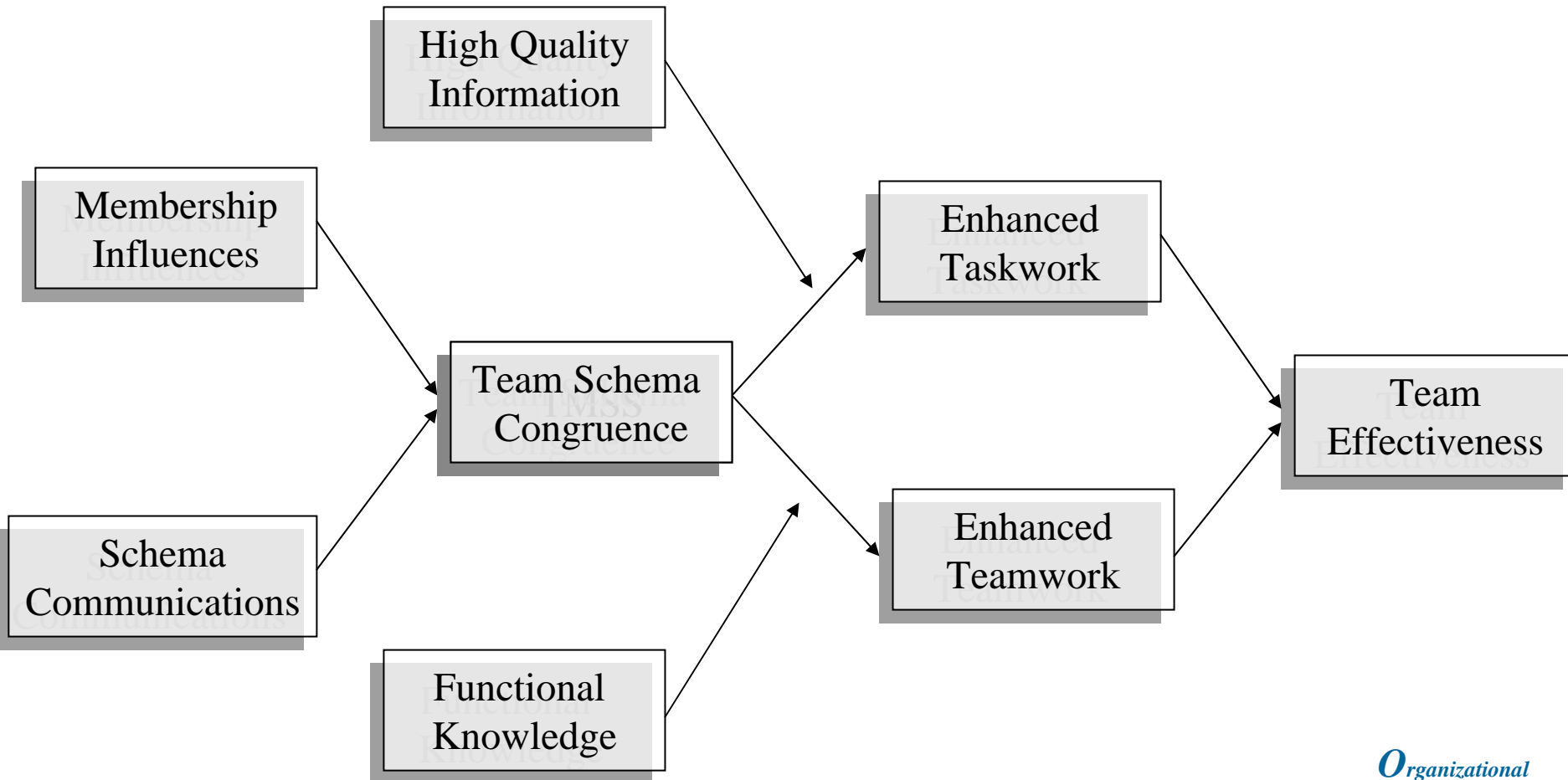
Research Questions: Background

Collaboration & Meaning Analysis Process (C-MAP)

Based on schema communication processes

Externalizing knowing & understanding

Articulation of underlying understanding
& meaning formation

Research Questions

Hypotheses were generated based on TMSS research and on the Structural Model of Team Collaboration

Knowledge building, knowledge interoperability, shared understanding related to high team functioning

Research Questions

Hypothesis 1: Teams using the C-MAP will have higher knowledge interoperability than teams not using this process.

Hypothesis 2: Teams using the C-MAP will have more congruent knowledge structures than teams not using this process.

Research Questions

Hypothesis 3: Teams using the C-MAP will have higher levels of performance than teams not using this process.

Hypothesis 4: Knowledge interoperability and congruent knowledge structures will predict team performance.

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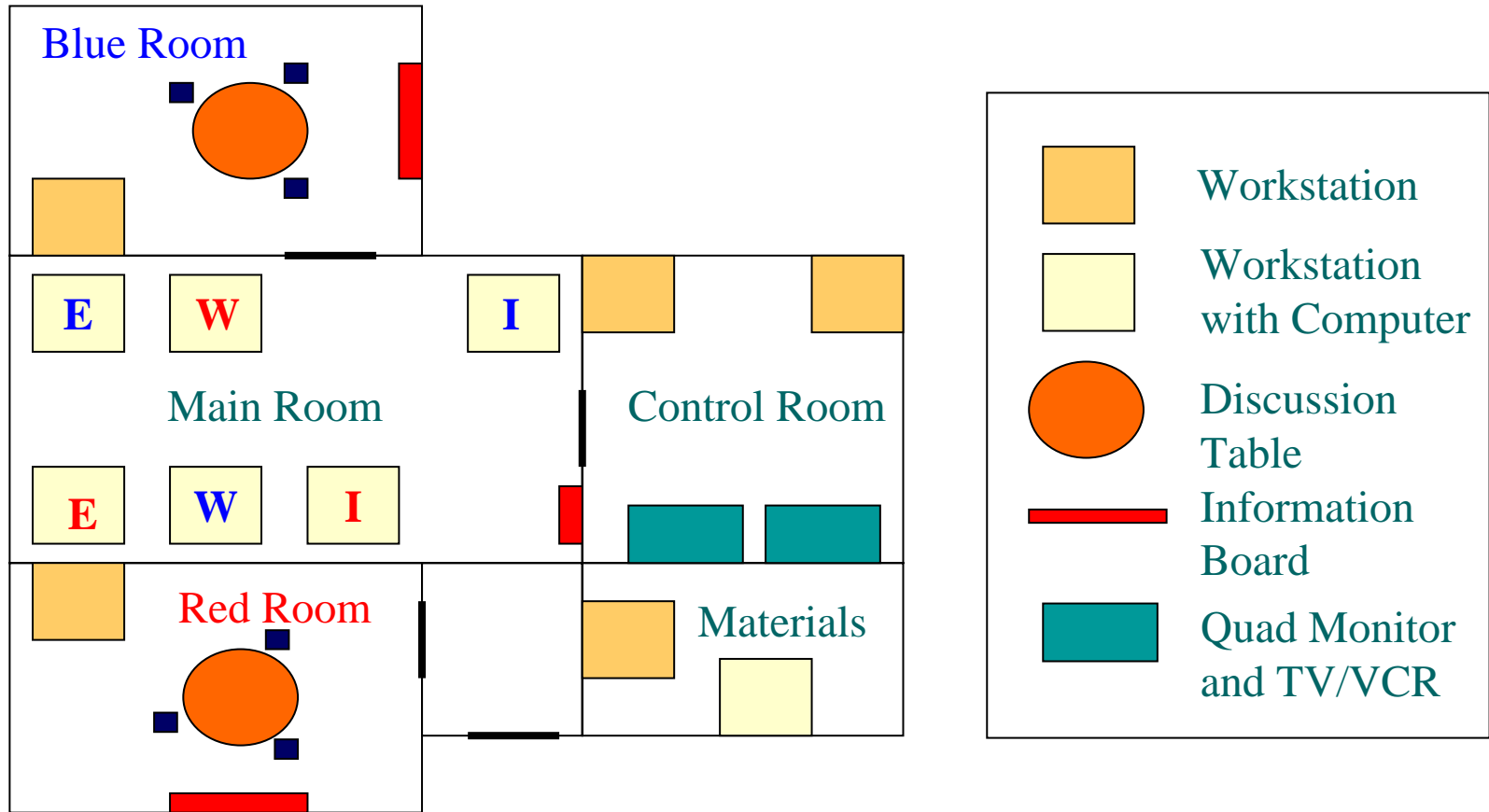*Joan R. Rentsch, Ph.D.*

Initial Experiment

Sample

147 UT college students randomly assigned to
49 teams of 3 members

Task

NEO

    - conducted an analysis of the task

    - 2 pilot teams to learn about task

Lab Layout

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Initial Experiment

Intro:
- Overview
- Consent
- Cognitive Ability

Control

CMAP Intervention:
- Comm Prompts
- Info Board Example
- Interactive Example

Preparation Time

Mission Discussion

ASK: Part I Knowledge Recall

ASK: Part II
- Sorting
- Labeling
- Rating

Attitudinal Measures:
- Equity
- Satisfaction
- Effectiveness
- Agreement
- CMAP
- Trust
- Viability

Knowledge Interoperability Measure

Debrief and Payment

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Initial Experiment

C-MAP Manipulation

- Training
- Role blurb
- Prompts
- Information Board (posted & structured knowledge)

Sample C-MAP Prompts

What do you know that your teammates must know?
TELL WHAT

What do your teammates know that you must know?
ASK WHAT

How are pieces of information related?
TELL CONNECTIONS

How do your teammates believe pieces of information are related?
ASK for CONNECTIONS

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C-MAP Interactive Example

John owns a loft at 121 West Street and rents it out for parties and other events.

John just bought an old property at 645 Gay Street for parties and is living in his loft on West Street.

There is a trance music DJ available that will offer a nice discount to perform at the party

There was a fire last night that destroyed several properties on Gay Street from 590 to 660.
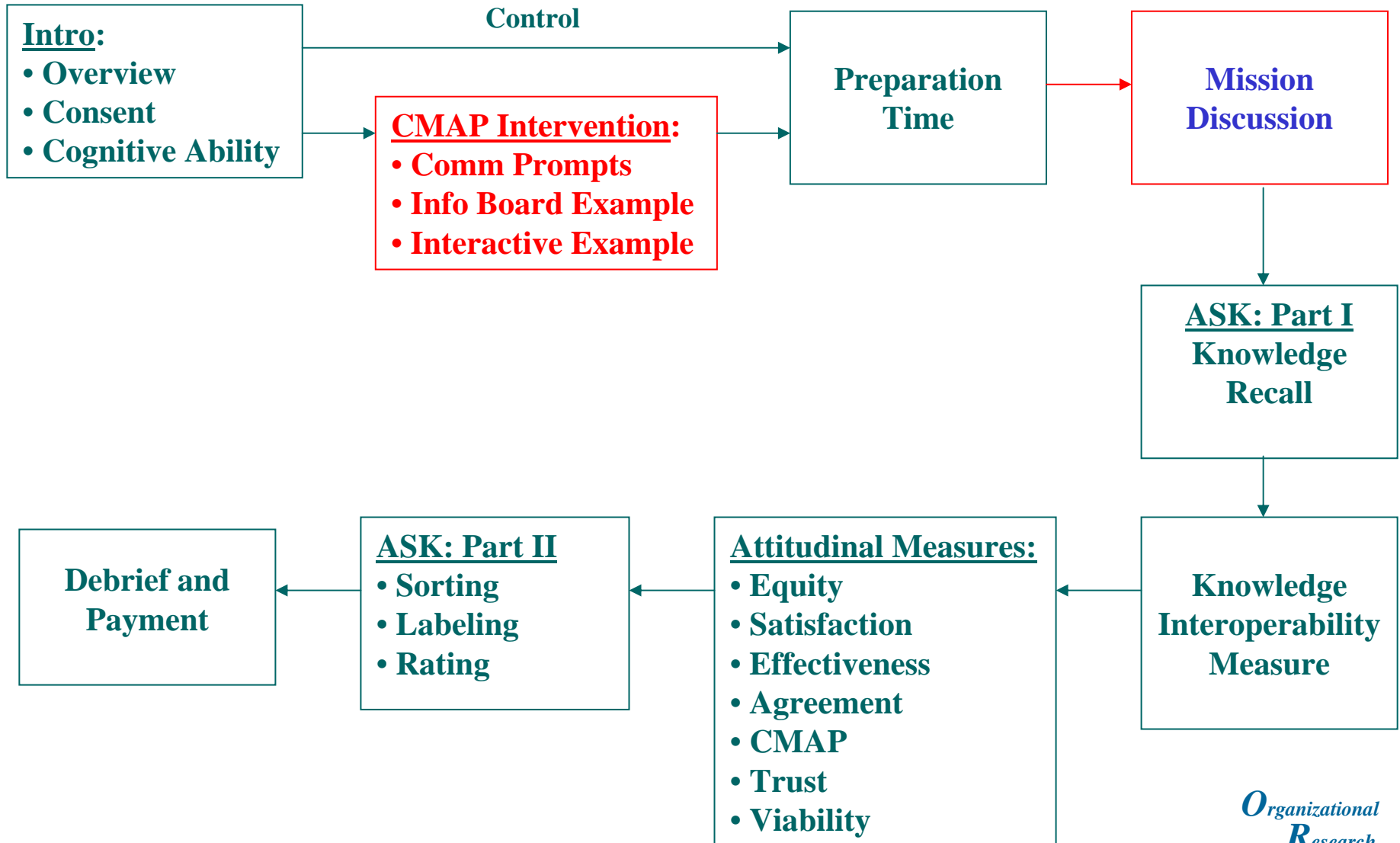
We need to find a new location!!

We can hire This DJ!

The party is an engagement party Betty and Joe who hate trance music.

The DJ is a good friend of Joe's and he's willing to play country music, which is Betty and Joe's favorite.

Initial Experiment

Intro:
- Overview
- Consent
- Cognitive Ability

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Knowledge Interoperability Measure

Debrief and Payment

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ASK: Part I
Knowledge Recall

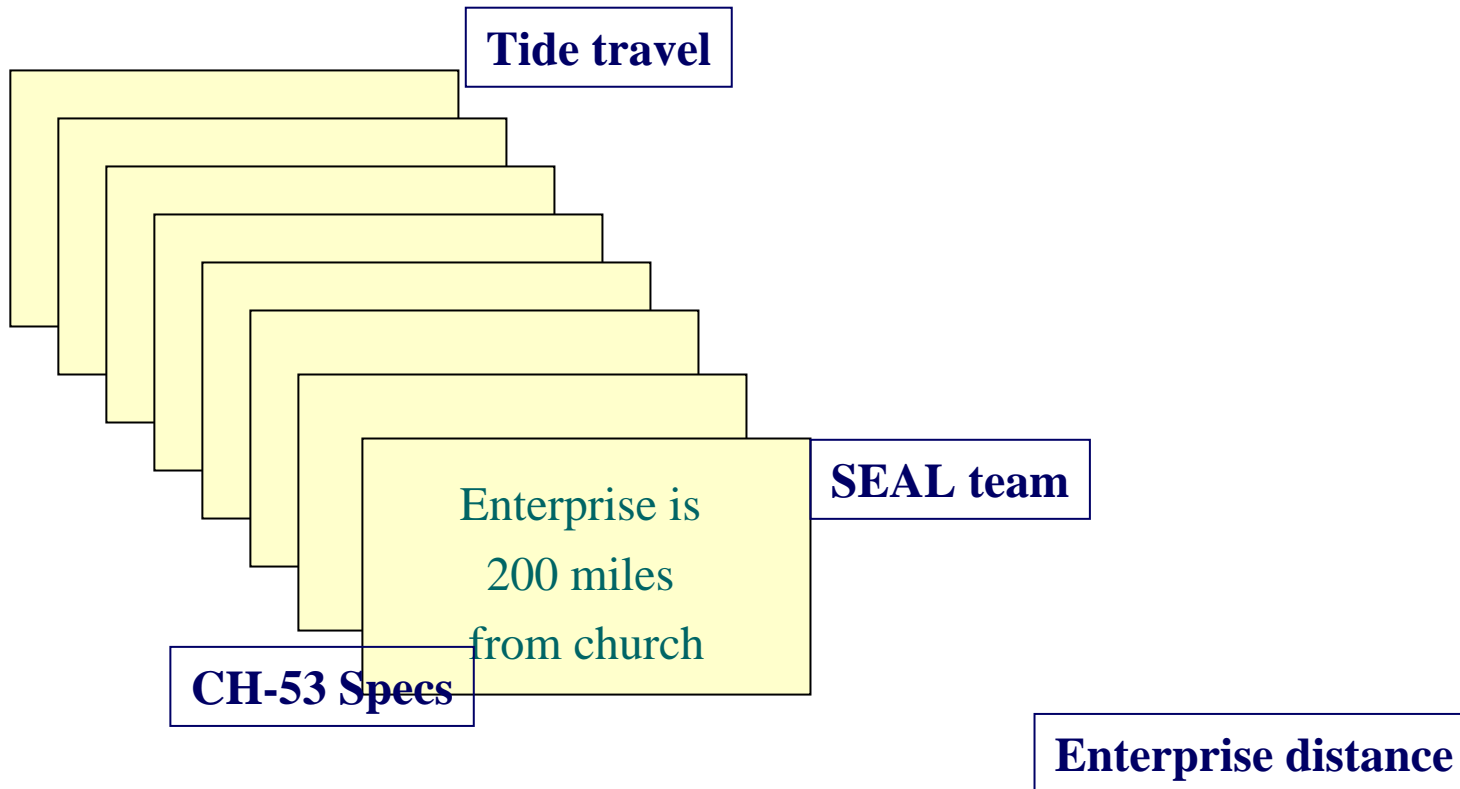| 2	High tide is from 7am-9am and 8pm-10pm
6	The CH-53 has a range of 500 miles
4	It takes a SEAL team 45 minutes to get from the shore to the church
7	A SEAL team consists of 7 people
1	Zodiacs have a speed of 15 miles per hour
10	A SEAL or Army team can parachute from a C-130
5	The CH-53 cannot fly in fog
8	The USS Enterprise is 200 miles from the church
3	High tide is about 2 feet
9	Helicopters can be heard within 5 miles

ASK: Part I
Knowledge Recall

INFO RECALL LIST
High tide is from 7am-9am and 8pm-10pm
The CH-53 has a range of 500 mi
It takes a SEAL team 45 minutes to get from shore to church
Zodiacs have a speed of 15 mph
The CH-53 cannot fly in fog
High tide is about 2 feet
A SEAL team has 7 people
Enterprise is 200 mi from church
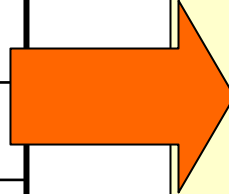
High tide is from 7am-9am and 8pm-10pm	The CH-53 has a range of 500 mi
SEALS = 45 minutes shore to church	Zodiacs have a speed of 15 mph
The CH-53 cannot fly in fog	High tide is about 2 feet
A SEAL team has 7 people	Enterprise is 200 miles from church

ASK: Part II
Sorting and Labeling

Tide travel

SEAL team

Enterprise is
200 miles
from church

CH-53 Specs

Enterprise distance

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ASK: Part II
Sorting and Labeling

Tide travel

High tide is from 7am- and 8pr

High tide is about 2 feet

diacs have a d of 15 mph

SEAL team

A SEAL team has 7 people

EALS = inutes church

CH-53 Specs

The CH-53 a range o 500 mi

The CH-53 cannot fly in fog

Enterprise distance

Enterprise is 200 miles from church

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ASK: Part II
Similarity Ratings

Rate how similar the groups are on a scale from
-5 (Very Dissimilar) to +5 (Very Similar)

	Tide travel	SEAL team	CH-53 Specs	Enterprise Distance
Tide travel				
SEAL team	0			
CH-53 Specs	3	-3		
Enterprise Distance	2	-4	3	

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Initial Experiment

Measures

Congruent Knowledge Structures -
**Adaptive Structured Knowledge (ASK)
Assessment**

Knowledge Interoperability - 75 items (based on task analysis)

Team Process - 2 raters coded 5-minute segments
tell/ask what, tell/ask why, tell/ask agreement,
tell/ask connections

Team Performance - 2 raters scored Final Plans

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Initial Experiment

Pilot teams (n = 6)
   Refined instructions, technology,
   C-MAP manipulation

Preliminary Results

Random assignment confirmed
(e.g., no differences between conditions for
gender, familiarity, cognitive ability)

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Initial Experiment's Results

Hypothesis 1: Teams using the C-MAP will have higher knowledge interoperability than teams not using this process.
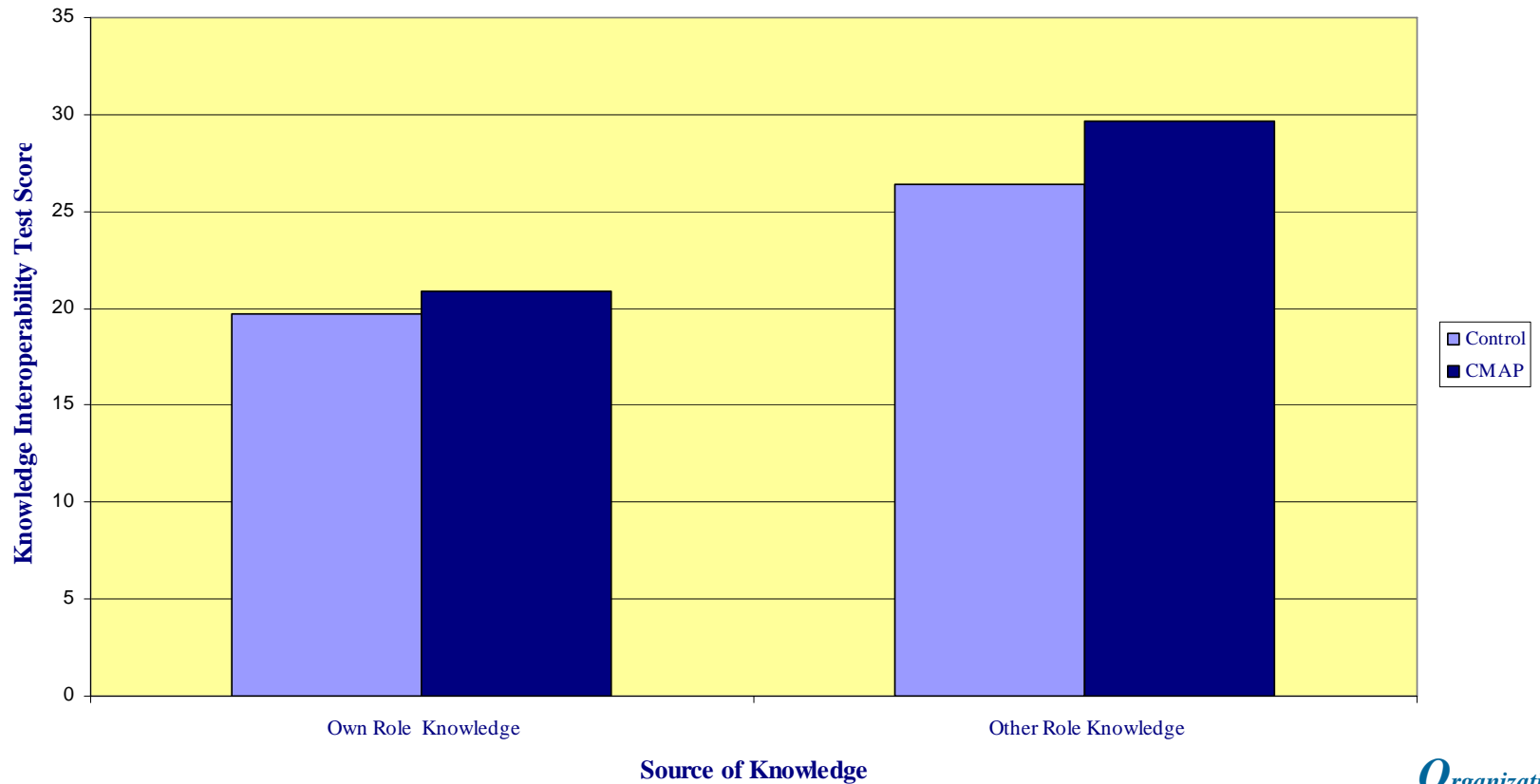
Initial Experiment's Results

Knowledge Interoperability $\quad t = 2.28*$
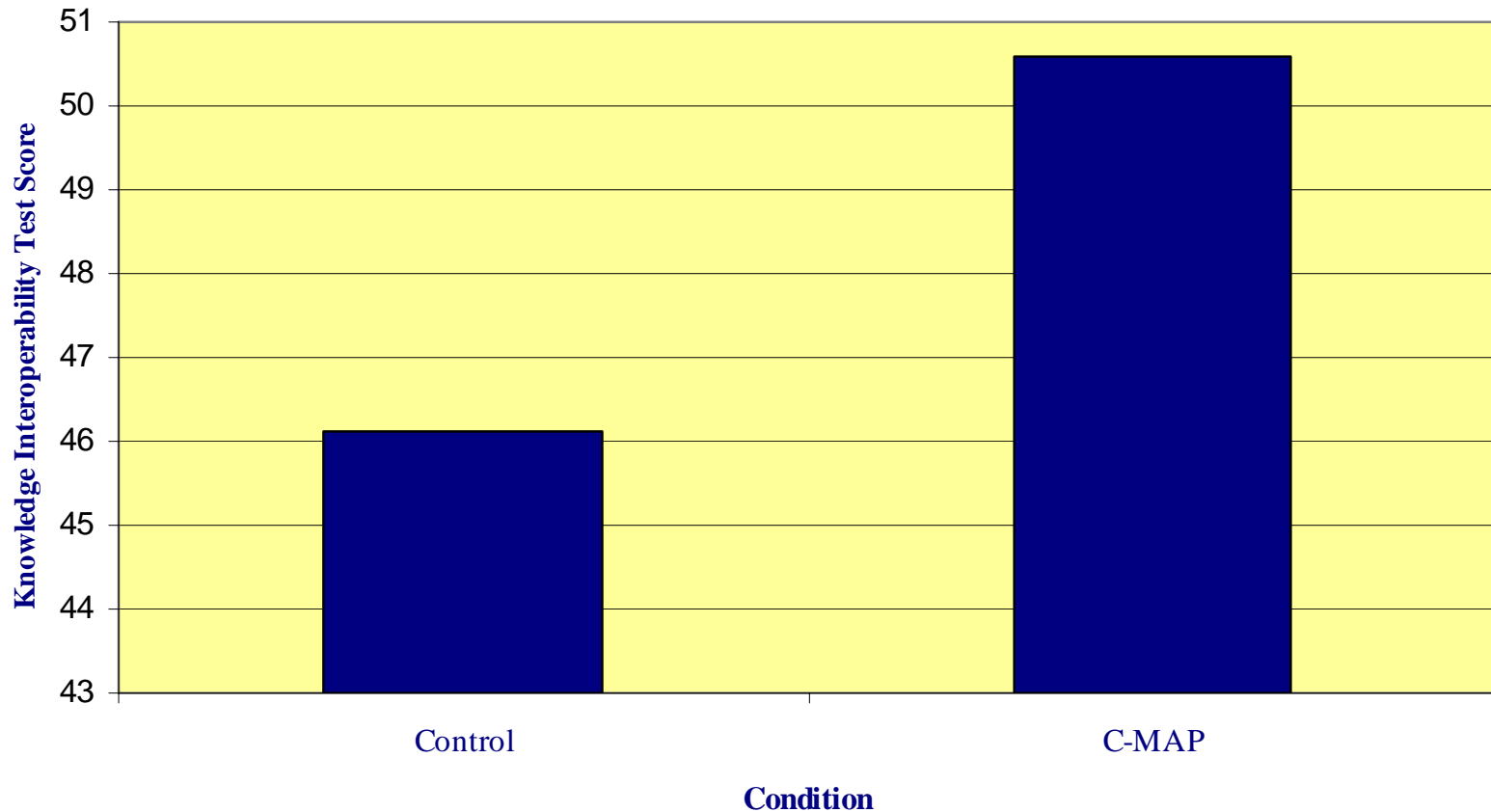
Initial Experiment's Results

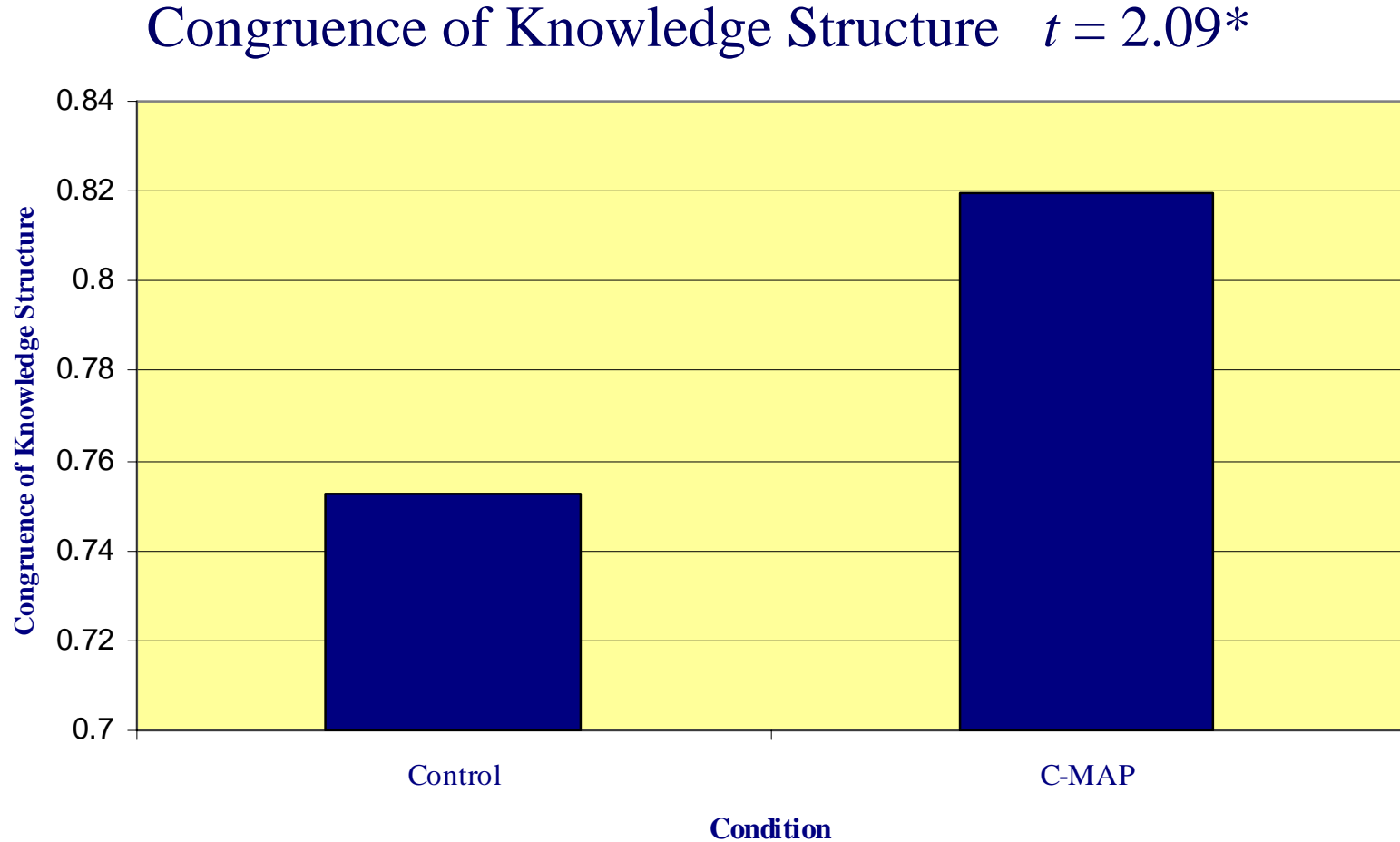Own Role Knowledge $t = 1.99, p = .054$
Other Role Knowledge $t = 2.06*$

Initial Experiment's Results

Hypothesis 2: Teams using the C-MAP will have more congruent knowledge structures than teams not using this process.

Initial Experiment's Results

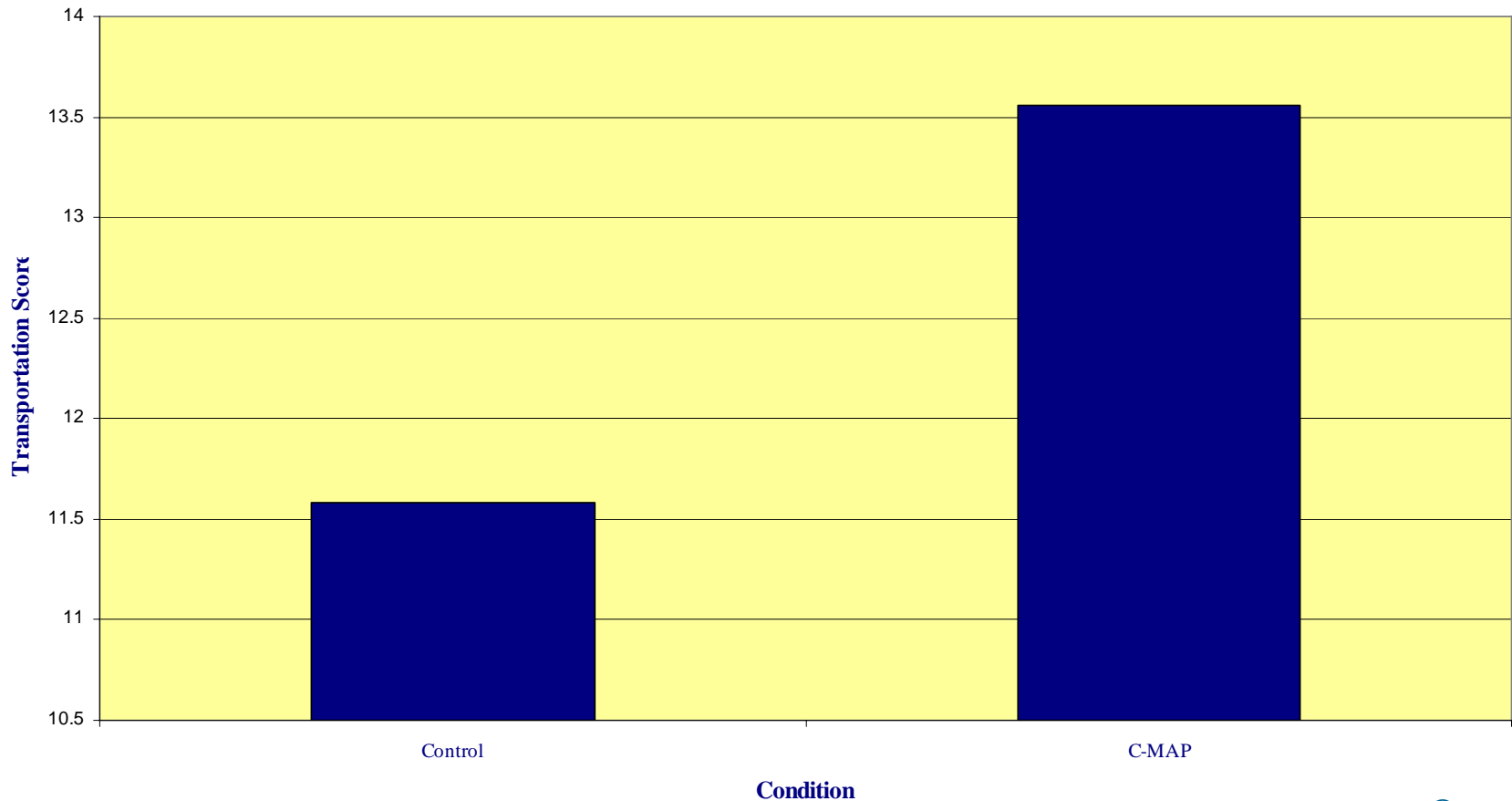### Congruence of Knowledge Structure $t = 2.09*$

Initial Experiment's Results

Hypothesis 3: Teams using the C-MAP
will have higher levels of performance
than teams not using this process.

Initial Experiment's Results

Transportation Score   r = .28*
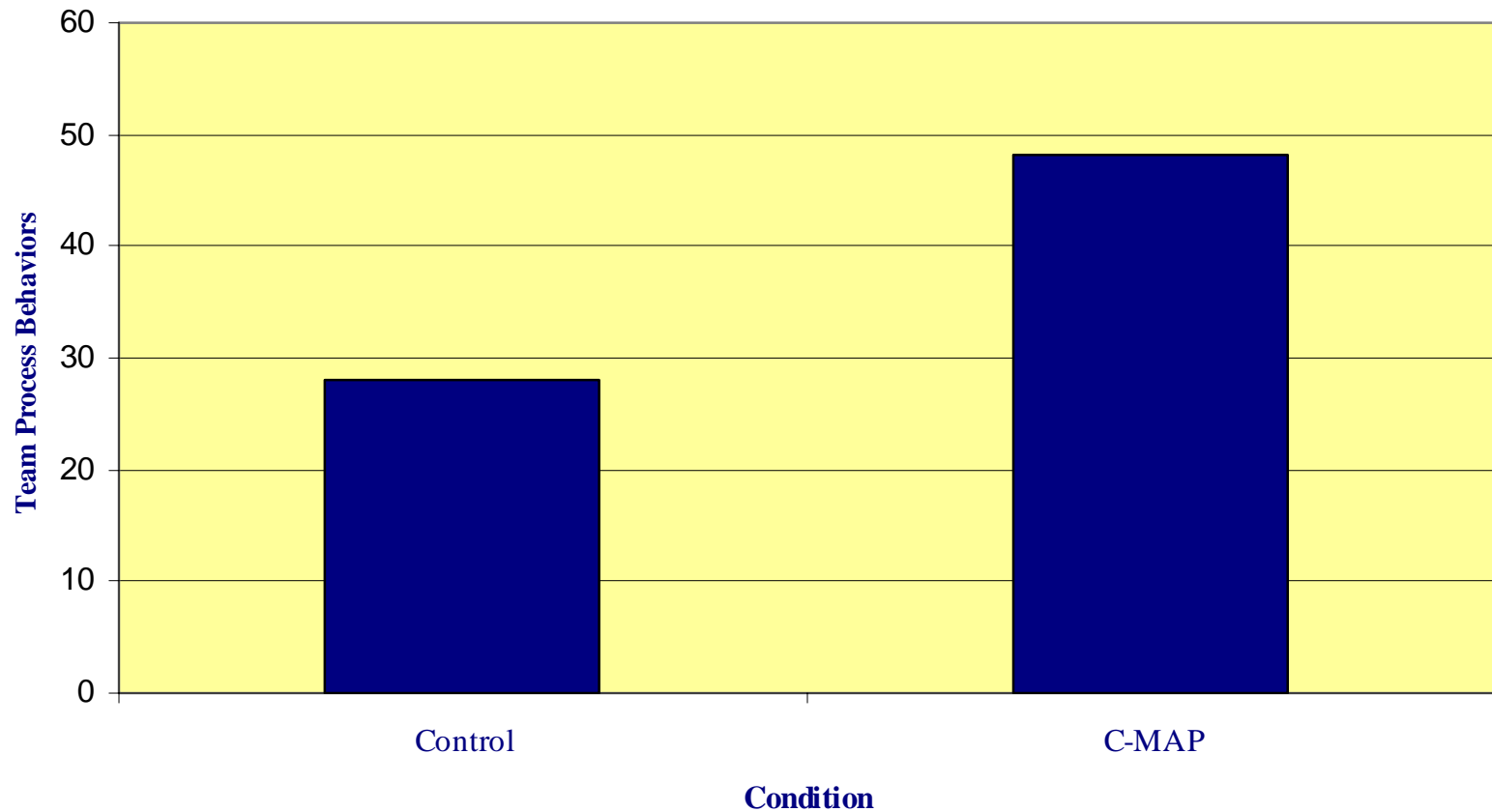
Initial Experiment's Results

Hypothesis 4: Knowledge interoperability and congruent knowledge structures will predict team performance.

No significant results for congruent knowledge structures
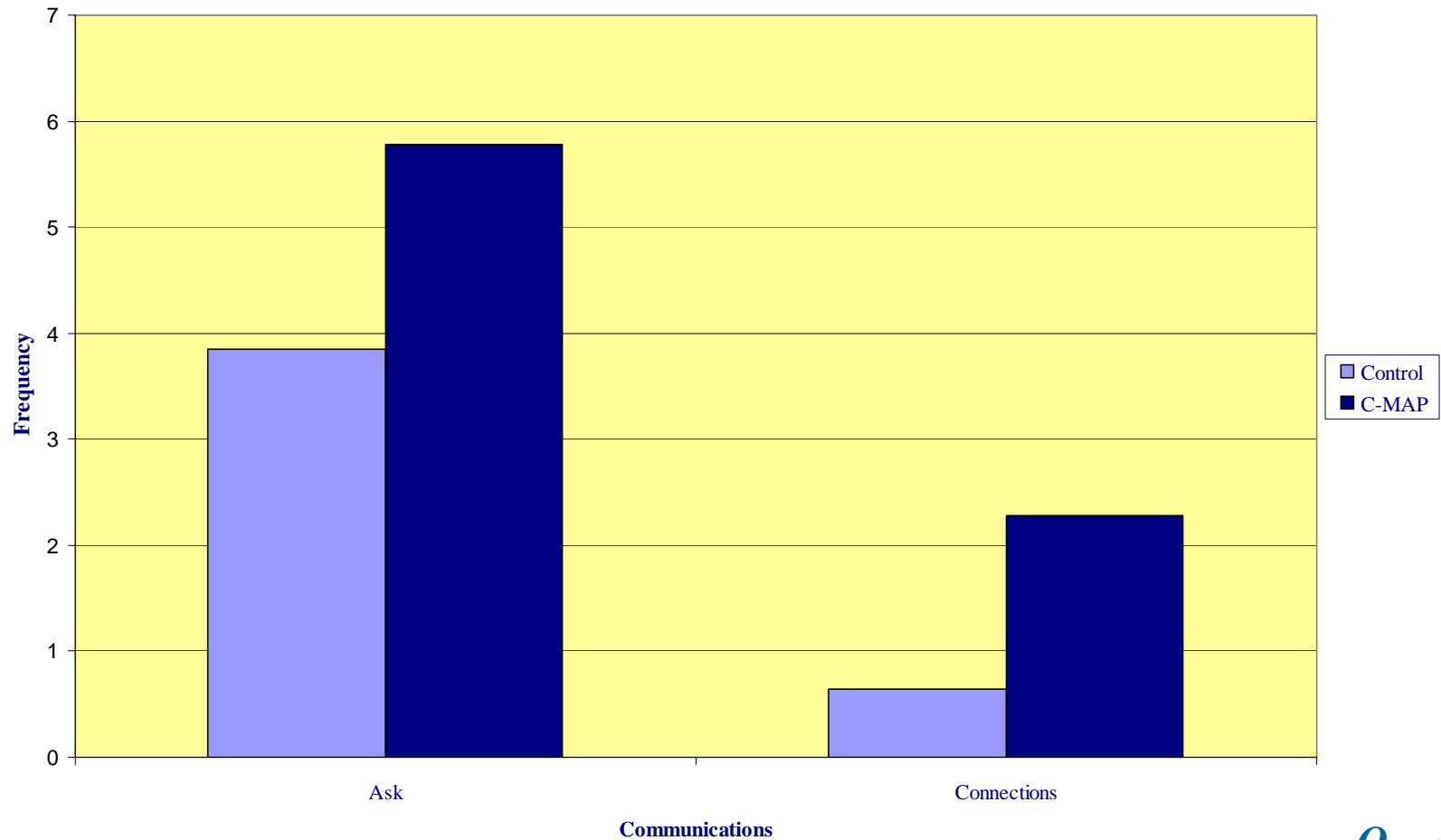
Other Role Knowledge and Transportation Score r = .30*

Initial Experiment's Results
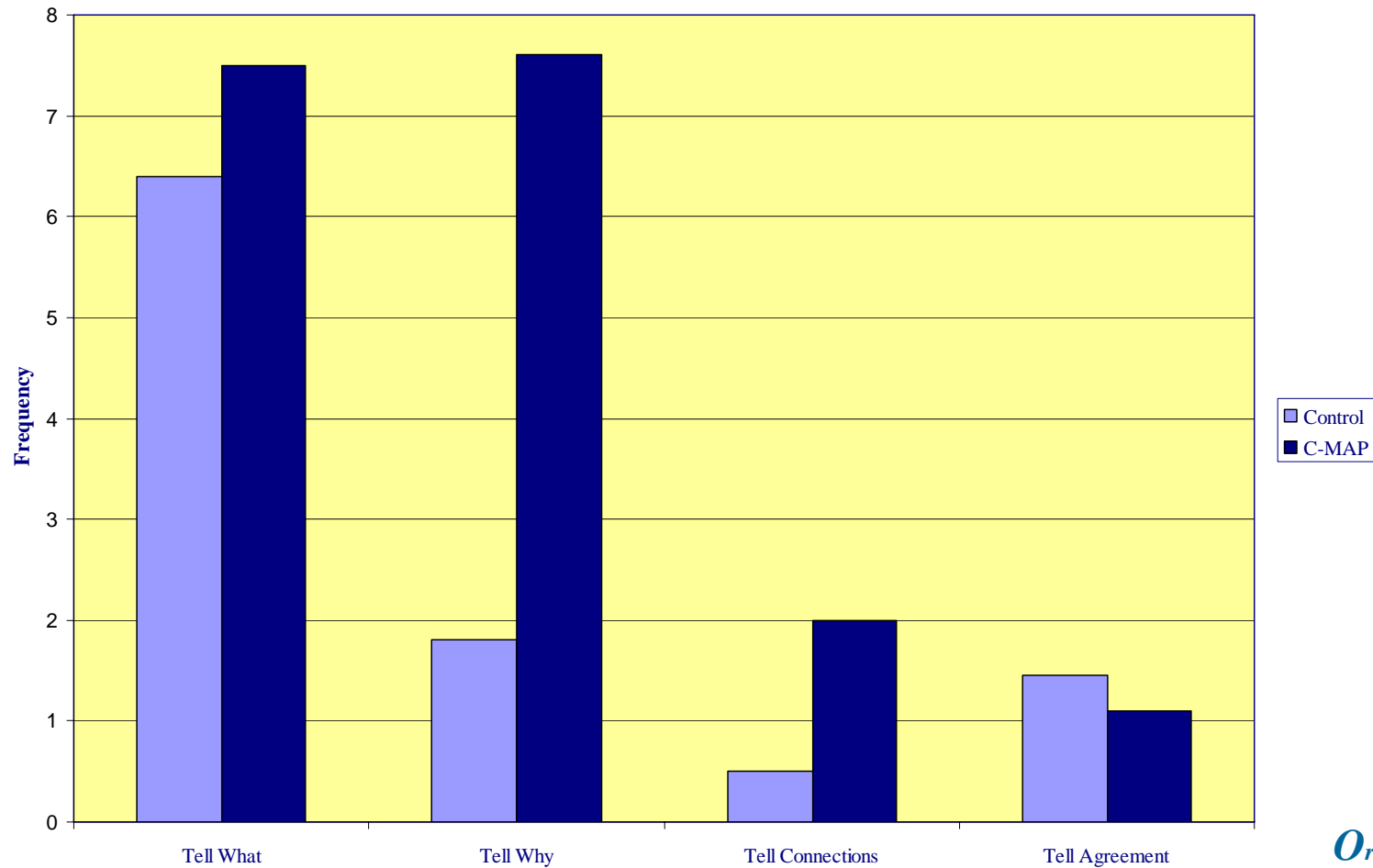
C-MAP associated with improved Team Process $t = 2.41*$

Initial Experiment's Results

Ask $\qquad$ $t = .03*$

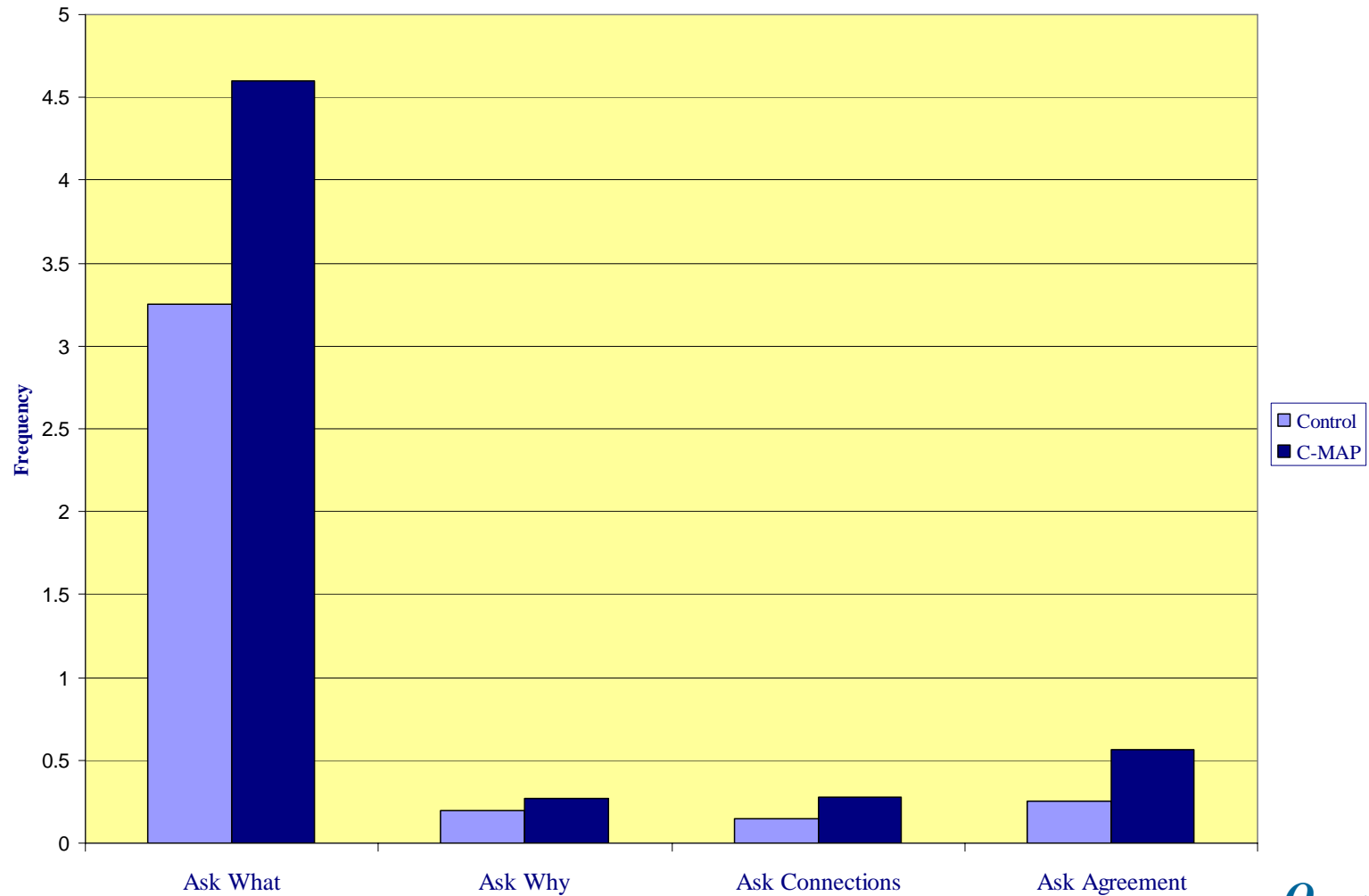Connections $\qquad$ $t = .01*$

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Initial Experiment's Results

Tell connections $t = 2.73*$

Initial Experiment's Results

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Next Project's Objectives & Approach

Expand lab to 6 networked computers & Ewall interface

Develop experimental stimuli & materials

Conduct a study using distributed teams

Improve measures (process measure), stimuli, & design

Technical Contributions

Adaptive Structured Knowledge (ASK) Tool

The C-MAP can be encoded into technology designed to facilitate team functioning and performance based on the ACE-IT model

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C-MAP Contribution to Collaboration Technology

Collaborative behavior was affected by knowledge externalization & prompting, which can be built into support technologies
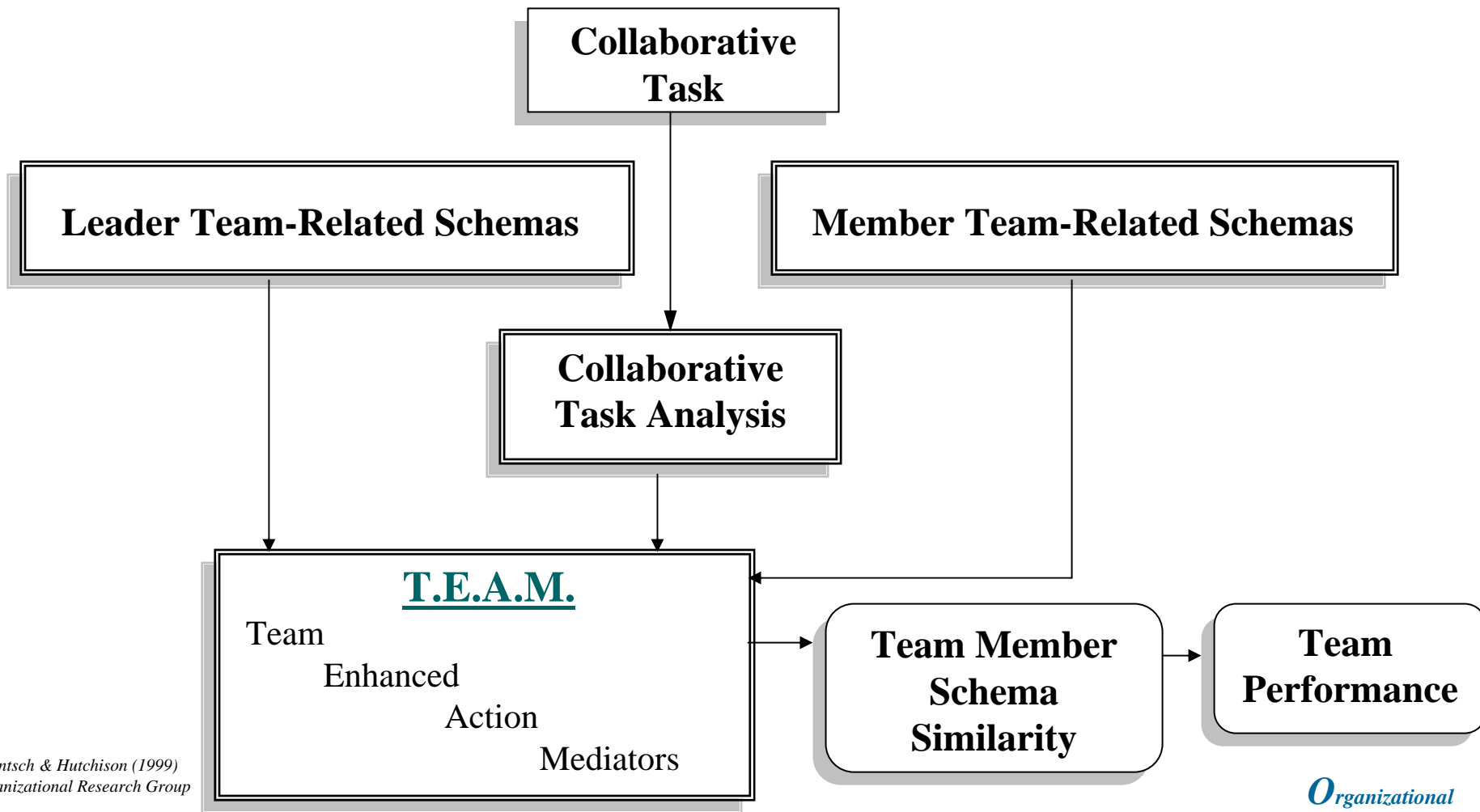
Knowledge interoperability was affected by knowledge externalization & prompting, which can be built into support technologies

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C-MAP Contribution to Collaboration Technology

C-MAP as scientifically based foundation for building
support technology

- Externalization of knowledge structures/schemata
- Prompting transfer and development of knowledge
- Increasing knowledge interoperability
- Increasing shared understanding
- Increasing team member schema similarity

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Advanced Cognitive Engineered
Intervention Technologies (ACE-IT) ™

Collaborative Task

Leader Team-Related Schemas

Member Team-Related Schemas

Collaborative Task Analysis

T.E.A.M.

Team
   Enhanced
      Action
         Mediators

Team Member Schema Similarity

Team Performance

Rentsch & Hutchison (1999)
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Advanced Cognitive Engineered Intervention Technologies (ACE-IT)[TM]

Preliminary pilot test indicates T.E.A.M.s embedded in software improved team performance on a simulated military task

Rentsch & Hutchison (1999)
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Expected Final Products

C-MAP as a scientifically-based
foundation for building
support technology

The C-MAP research program will contribute to:

The development of
methods for
representation and
transfer of meaning

The understanding of
the processes of team
cognition

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Potential Impact

Influence the development of support technology

Provide empirically tested, theoretically derived hypotheses to shared understanding research

Contribute methodological innovations

Contribute to the understanding and measurement of the development of congruent knowledge structures and contribute to testing the Structural Model of Team Collaboration

Planned Publications

Expect to present this study at a conference

Expect to prepare a manuscript for submission to
journal based on this study

Master's thesis based, in part, on these data